REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
		Final Technical Report 9/1/93-11/30/94

4. TITLE AND SUBTITLE
Dynamical Systems, Neural Networks and Cortical Models

5. FUNDING NUMBERS
F49620-93-1-0522
(AASERT)

6. AUTHOR(S)
Morris W. Hirsch

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Center For Pure and Applied Mathematics
University of California
Berkeley, CA 94720

8. PERFORMING ORGANIZATION REPORT NUMBER
AFOSR-TR-95-0453
1-443964-22537

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Office of Scientific Research/PKA
110 Duncan Avenue Suite B115
Bolling Air Force Base, Washington, D.C. 20332-0001

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
F49620-93-1-0522
(AASERT)

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release;
distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Abstract

Work was done on an oscillating neural network "computer" that could recognize sequences of characters of a grammar. It was extended to employ selective control of synchronization to direct the flow of communication and computation within the architecture to solve a grammatical inference problem.

Because intercommunicating modules of the architecture are analytically guaranteed to store and recall multiple oscillatory and chaotic attractors, the architecture served as a framework in which to arrange and exploit the special capabilities dynamic attractors.

In this architecture, oscillation amplitude codes the information content or activity of a module (unit), whereas phase and frequency are used to "softwire" the network. Only synchronized modules communicate by exchanging amplitude information.

Chaotic attractors from the large family of Chua attractors were synchronized for operation in the architecture using techniques of coupling developed for secure "broadspectrum" communication by a modulated chaotic carrier wave.

14. SUBJECT TERMS			15. NUMBER OF PAGES
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

FINAL TECHNICAL REPORT

AASERT93/Dynamical Systems, Neural Networks, and Cortical Models

Morris W. Hirsch (PI)
Dept Mathematics, U.C.Berkeley,
Berkeley, Ca. 94720, 510-642-4318

Bill Baird (Assist. Research Mathematician)
Dept Mathematics, U.C. Berkeley

Walter Freeman (Collaborator)
Dept Molecular and Cell Biology, U.C. Berkeley

Mathematics resource manager: Bernice Gangale 510-642-0116

Period: 9/1/93 - 11/30/94

Principal Investigator - Morris Hirsch

Department chair - F. Alberto Grunbaum

Director of the Center for Pure and Applied Math - Alan Weinstein

Contact and Grant officer - Pat Gates

1 Specific Progress

Work was done on an oscillating neural network "computer" that could recognize sequences of characters of a grammar. It was extended to employ selective control of synchronization to direct the flow of communication and computation within the architecture to solve a grammatical inference problem.

Because intercommunicating modules of the architecture are analytically guaranteed to store and recall multiple oscillatory and chaotic attractors, the architecture served as a framework in which to arrange and exploit the special capabilities dynamic attractors.

In this architecture, oscillation amplitude codes the information content or activity of a module (unit), whereas phase and frequency are used to "softwire" the network. Only synchronized modules communicate by exchanging amplitude information.

Chaotic attractors from the large family of Chua attractors were synchronized for operation in the architecture using techniques of coupling developed for secure "broadspectrum" communication by a modulated chaotic carrier wave.

The capabilities of this architecture were explored by application to the well studied problem of grammatical inference. Even though it is constructed from a system of continuous nonlinear ordinary differential equations, the system can operate as a discrete-time symbol processing architecture, but with analog input and oscillatory subsymbolic representations.

The architecture operates as a thirteen state finite automaton that generates the symbol strings of a Reber grammar. It was designed to demonstrate and study the following issues and principles of neural computation: (1) Sequential computation with coupled associative memories. (2) Computation with attractors for reliable operation in the presence of noise. (3) Discrete time and state symbol processing arising from continuum dynamics by bifurcations of attractors. (4) Attention as selective synchronization controling communication and temporal program flow. (5) chaotic dynamics in some network modules driving randomn choice of attractors in other network modules.

To advance intuition for theoretical analysis, interactive simulations of the network applications were designed on the SGI 4D35G Personal Iris Graphics Workstation. These allowed real time graphic display of network dynamics and learning as parameters were varied.